CIS WORKING PAPER

Nr. 71 , 2011

published by the Center for Comparative and International Studies (ETH Zurich and University of Zurich)

Market mechanisms for adaptation to climate change - lessons from mitigation and a pathway to implementation

Sonja Butzengeiger-Geyer
Axel Michaelowa
Michel Köhler
Martin Stadelmann

Center for Comparative and International Studies (CIS), IPZ University of Zurich

Perspectives GmbH (Hamburg, Germany)

Universität Zürich[UZH]

ETH Eidgenössische Technische Hochschule Zürich Swiss Federal Institute of Technology Zurich

Market mechanisms for adaptation to climate change - lessons from mitigation and a pathway to implementation

14th November 2011

Sonja Butzengeiger-Geyer+, Axel Michaelowa, Michel Köhler+, Martin Stadelmann**

Abstract

Adaptation to climate change impacts can be proactive or reactive. Adaptation can have the character of a private good, a club good or a public good depending on the nature of the action. Thus underprovision of adaptation is likely if left to private initiative, and public policy instruments are required that incentivize adaptation. Such instruments should be as efficient as possible, and in other policy fields market-based mechanisms have been used to maximize efficiency. So far however, there is almost no experience with adaptation taxes, tradable project-based offsets or tradable allowances, whereas climate change mitigation has been a field where such instruments have been widely applied during the last two decades. While generally, market-based instruments for mitigation can be seen as successful, several key lessons have been learned. Pilot phases are important to test an instrument and to correct design flaws. Distortions by lobbies can lead to adverse distributional effects. Regulatory uncertainty reduces the efficiency gains.-Transaction costs can form a significant barrier.- Monitoring and independent verification are key to prevent fraud. These lessons should be taken into account in the design of market mechanisms for adaptation, and we derive requirements for that. Finally, we discuss a concrete pathway to establishing market mechanisms for adaptation and define priorities for further research and possible pilot implementation, differentiating by types of adaptation.

Keywords: Climate change, adaptation, market mechanisms, policy instruments

+ *Perspectives GmbH, Fenglerstr. 9a, D-22041 Hamburg, Germany*

* *Center for Comparative and International Studies, University of Zurich, Affolternstrasse 56, CH-8050 Zürich, Switzerland, Corresponding author: martin.stadelmann@pw.uzh.ch*

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1. Background of market mechanisms in the context of adaptation and objectives of the paper

Global greenhouse gas emissions are inexorably creeping upwards despite two decades of climate policy. Even the financial crisis of 2008 has not dented this increase. As Metz et al. (2007) have shown, even rapid successes in greenhouse gas mitigation would not prevent significant anthropogenic climate change. By 2010 the average global temperature increase since the late 19th century had already reached 0.7°C. Recent analyses of the pledges made by countries under the Copenhagen Accord (Rogelj et al. 2010, European Climate Foundation 2011) show that they are unlikely to keep global temperature increase below 2°C. And whether the pledges will actually be reached depends on the political salience of the climate change problem, which since its historic high in 2007 has decreased considerably. Moreover, the nuclear accident at Fukushima has put into doubt an emissions mitigation technology seen as important by many climate policy analysts. Given this gloomy background, adaptation to climate change gains in importance, especially as developing countries are likely to be impacted relatively strongly by even relatively small amounts of climate change, especially if situated in the tropics. Poor countries already now suffer from an "adaptation deficit" to current climate variability. For the year 2030, the UNFCCC (2007) estimates annual global adaptation costs at 49 to 171 billion $, with 27 to 66 billion accruing in developing countries. Parry et al. (2009) argue that these numbers are on the low side due to the exclusion of mining and manufacturing, energy, retailing, and tourism, neglect of a number of vector-borne diseases, and the World Bank (2010) estimates annual adaptation costs for developing countries at 70-100 billion $. The sectoral distribution of these costs is shown in Table 1.

Table 1: Sectoral adaptation costs in developing countries (billion $)

Sector	UNFCCC (2007)	World Bank wet scenario	World Bank dry scenario
Infrastructure	2-41	27.5	13
Coastal zones	5	28.5	27.6
Water supply and flood protection	9	14.4	19.7
Agriculture, forestry, fisheries	7	2.6*	2.5*
Human health	5	2	1.5
Extreme weather events	—	6.7	6.4
Total	**28-67**	**81.5**	**71.2**

Source: World Bank (2010, p. 14)

In that context, developing countries have consistently asked industrialized countries to provide financial resources for adaptation. In the Copenhagen Accord, industrialized countries have pledged 30 billion $ as "fast start finance" for mitigation and adaptation in developing countries with a view to increase financing to 100 billion $ annually by 2020. However, the modalities of financing remain vague and industrialized countries have taken care to include all types of channels – bilateral, multilateral, concessional, private and even market mechanisms. So far, industrialized countries have

been unwilling to use multilateral channels and have stuck to bilateral financing modes without being particularly transparent.

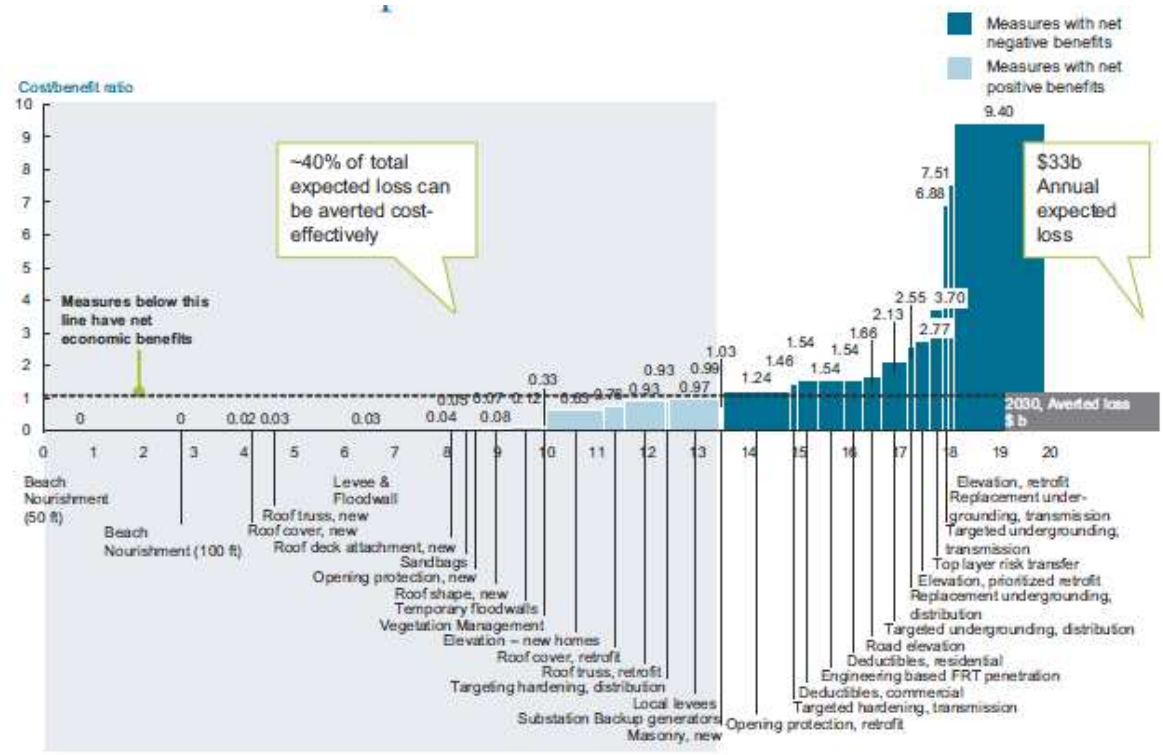
The few multilateral funds are even heavily dispersed to several funds: three multilateral funds have each around 150-250 million $ of funding: the Adaptation Fund financed by a levy on Clean Development Mechanism (CDM), the Least Developed Countries Funds (LDCF) and the Special Climate Change Fund (SCCF) (Climatefundsupdate, 2011). While the Adaptation Fund has the potential to become the largest of the three due to the steady inflow of the CDM levy (at least if there is an ambitious agreement on the international climate policy framework on UN-level), it may need some time to reach the Program for Climate Resilience (PPCR), part of the Climate Investment Funds, which has raised more than 900 million USD, of which 300 are deposited (Climatefundsupdate, 2011).

Due to this unclear and heterogeneous financing situation, there is a real risk that funding for adaptation could be spent in a haphazard way that repeats a lot of the mistakes made in development assistance in the past decades. To avoid a future "climate finance fatigue" generated by industrialized country taxpayers asking whether spending has been effective and efficient, new mechanisms need to be discussed that could help to achieve an efficient outcome of adaptation funding.

In contrast to mitigation of climate change, at first glance most forms of adaptation are not a global public good. Adaptation can occur along a continuum ranging from a pure private good (e.g. protecting a clearly delimited real estate property against flooding) over a club good (protecting agricultural yields through an improved irrigation system) towards a global public good (breeding of highly drought-resistant cultivars). Economists normally use different types of instruments to address such different goods (e.g. Mendelsohn (2006) proposes to use public instruments to enable biodiversity-related adaptation, public-private partnerships in the water sector, while leaving adaptation in the agricultural sector to market forces). However, if one defines adaptation more broadly as protection of societies as a whole against impacts of climate change, it generally can be seen as public good, similarly to the provision of public security.

As shown by Economics of Climate Adaptation (2009), unit costs of adaptation projects can differ by orders of magnitude (see Figure 1).

Figure 1: Differences of unit costs of hurricane damage protection projects in Florida



Source: Economics of Climate Adaptation (2009), p. 109

Thus efficiency of adaptation funding can be improved by choosing least-cost solutions, e.g. through market-based mechanisms to allocate funding.

Definition of market mechanisms for the purpose of this paper

The key feature of market mechanisms (or market-based instruments) is that a price signal is used to promote the production of a certain service or good, or to reduce it (see Stavins 2003).

The quest for efficient policy instruments has led environmental policymakers to go beyond mandatory regulation and to look into mechanisms that provide an incentive to reduce pollution where it can be done at lowest cost (see Gupta et al. 2007). While market mechanisms to address pollution were already proposed in the early 1970s, it took until the late 1980s until they were applied in practice, and until the mid-1990s to see large-scale implementation. In climate change mitigation, market mechanisms were first proposed in the early 1990s and have started actual implementation in the early 2000s (see Yamin 2005, Grubb et al 2010). By 2010, global markets for climate change mitigation reached a turnover of 92 billion € (Point Carbon 2011), dwarfing all other environmental market mechanisms with regards to size. Trading systems have also been introduced in the case of other scarce commodities, such as access to fisheries or production rights for milk.

Market mechanisms can take various forms. The purest one is the trading of quotas (obligations or permits). In case of obligations, each quota embodies the obligation to produce one unit of the public good. It needs definition of participants and a public regulation that requires surrendering quotas in a certain period. If one participant can produce the public good at low-cost, he can take over quotas from another participant and receives a market price. Another form is the generation of tradable units through projects that produce the public good. These units can be used to comply with a public

regulation. Instead of obligations to produce a minimal quantity of the public good, quotas can also be used to limit pollution: permits to produce a certain (maximum) amount of environmental pollution can be allocated to participants whereas the permits can be traded. In the context of emissions mitigation, permit trading systems exist in a number of jurisdictions whereas project-based systems allow generating units ("offsets") through projects outside these jurisdictions; these units can then be imported into permit systems. The most famous example are the mitigation framework created under the Kyoto Protocol, and the European Emission Trading Scheme (EU ETS) – both allow the use of carbon reduction credits from the project – based mechanisms Clean Development Mechanism (CDM) and Joint Implementation (JI). Interestingly, the use of offsets was also a key feature of the US climate legislation proposed by the Obama administration in 2009.

Some authors and many policy makers also include taxes and subsidies in the definition of market mechanisms. It may be noted that, if one refers to common definitions of market mechanism[1], the validity of such a wide definition would require that these instruments apply a tax rate / grant level that is equal for each unit of the pollution / public good. In this paper, we regard taxes and subsidies also as market mechanisms, while we will mainly focus our analysis on quota systems.

Past analysis of market mechanisms for the purpose of adaptation

Regarding adaptation, with the exception of Callaway (2004), nobody has assessed the possibility to use market mechanisms. Callaway (2004, p. 281) proposed a system of adaptation credits "to narrow the difference between marginal benefits and marginal costs" but did not elaborate on it. A trading system for adaptation could also be specified in a way that it limits "risky activities", and thus would be similar to the permit trading systems for classical pollutants (Kuch and Gigli 2007). Here, activities that are likely to suffer from climate change impact would be capped. Anyone wanting to engage in such an activity would have to acquire an allowance. The price to be paid for the allowance deters people from engaging in the risky activity.

Where adaptation is linked to the reduction of resource use, market mechanisms have already been applied to optimize resource utilization, e.g. in the case of tradable water access rights (see Cantin et al. 2005, Grafton 2005 and Luo et al. 2003). However, classical literature on adaptation policy such as Fankhauser et al. (1999), Burton et al. (2002), Bo and Spanger-Siegfried (2004) and Agrawala and Fankhauser (2008) has not discussed market mechanisms et all.

[1] Such as: "The system whereby using prices, the interaction of supply and demand allocates inputs and distributes outputs" (http://www.finance-lib.com/financial-term-market-mechanism.html; accessed 16 April 2011) or "The way in which changes in prices influence the production of goods and services and the demand for them" (Financial Times Lexicon, http://lexicon.ft.com/Term?term=price-mechanism; accessed 16 April 2011)

Objectives of the paper

In this paper, we review policy instruments that can be used in the adaptation context and analyse experiences made with major market mechanisms that have been implemented in the field of greenhouse gas mitigation. Based on this, we derive requirements for the implementation of potential market mechanisms for adaptation. Finally, we discuss a concrete pathway to establishing market mechanisms for adaptation and conclude with priorities for further research and possible pilot implementation, differentiating by types of adaptation.

2. Policy instruments for adaptation

The following paragraphs describe the main instruments that can be used for adaptation, including challenges as well as barriers for implementation. We also discuss some policy instrument candidates for adaptation that have not yet been applied on a significant scale.

In chapter 3, we then describe lessons learned from major market mechanisms from greenhouse gas mitigation. This allows specifying applicability conditions and favourable design features of adaptation market mechanisms in chapter 4.

The range of policy instruments available for adaptation

Adaptation can be described as all activities aiming at preparing for or dealing with the impacts of climate change, be it at the level of individual households, communities and firms, or of entire economic sectors, governments and countries. Adaptation serves to reduce the damage resulting from the unavoidable impacts of climate change, as well as to protect lives and livelihoods (IPCC, 2007).

As one important reference, Agrawala and Fankhauser (2008) distinguish the following instrument *categories* relevant for key sectors: Insurance schemes (all sectors; extreme events), price signals / markets (water; ecosystems), financing schemes via Public-Private-Partnerships or private finance (flood defence, coastal zones, water), regulatory measures and incentives (infrastructure: building standards; zone planning), and research and development incentives (agriculture, health).

This categorisation does differentiate on the level of policy instrument categories, but not in detail between policy instruments. We therefore present an own, more detailed categorisation of major policy instruments in Table 2. Besides, Table 2 also indicates if the policy instruments have already been applied and which objective the policy instrument have. Adaptation policies can have one or several out of four main objectives (own categorisation of the authors). These are:

- Fund raising/mobilization for adaptation activities
- Efficient allocation of funds that are available for projects aiming to avoid climate change related damages (i.e. decision which adaptation activities are to be supported with available funds)
- Promotion of adaptation by various stakeholders (e.g. discouraging settlement in flood-prone areas)
- Sharing of financial risks in the context of climate change (e.g. transfer of risks through insurance based mechanisms)

Table 2: Policy instruments for adaptation

Policy instrument category	Major policy instruments for adaptation	Already applied in the context of adaptation, example	Main objective(s) of policy instrument
Non-market mechanisms			
Public Private Partnerships	• Service concessions • e over tiPublic • Public contracts	• Research for e.g. drought tolerant seeds • Flood barrier operation with shared public-private responsibility	• Promotion of adaptation & efficient allocation of funds & sharing of financial risks
Regulatory measures	• E.g. definition of no-settlement zones in risk-prone areas	• Planning and building acts • Ordinance on rainwater infiltration • Land use regulations • Procedures for flood protection • National planning frameworks	• Promotion of adaptation
Financial instruments (promotion of adaptation)	• Loans • Guarantees	• Not yet applied in the context of adaptation	• Promotion of adaptation
Financial instruments (risk financing)	• Indemnity-based • Index-based • Weather derivative • Cat bond	• Insurance-related instruments are in heavy usage today and there are novel forms under development.	• Sharing of financial risks
Market mechanisms			
Subsidies	• Direct payments and grants (competitive tendering or payment per unit) • Tax reductions • Price supports	• Education &information dissemination on potential risks and preventive measures • Use of new cultivars • Afforestation of degraded land • Building or improvement of dykes and other flood-protection measures • Weather-proofing of buildings • Early warning systems • Installation of water supply, desalination and irrigation systems in areas threatened by droughts • Installation of rainwater infiltration facilities for existing public and private buildings • Removal of housing from	• Promotion of adaptation

Policy instrument category	Major policy instruments for adaptation	Already applied in the context of adaptation, example	Main objective(s) of policy instrument
		floodplains or coastal areas endangered by storm surges • Resettlement of farms	
Taxes and fees	• Taxes to raise adaptation funds • Taxes to limit resource use	Taxes to raise funds • Regional flood protection levy • Flood reconstruction levy Taxes to limit resource use • Land use taxes and fees • Water taxes	• Promotion of adaptation and/or fund raising
Tradable quotas	• Adaptation Market Mechanism: obligation for entities to achieve adaptation units; tradability of quotas	• Not yet applied in the context of adaptation	• Fund raising/mobilization & efficient allocation of funds & promotion of adaptation
Project offsets	• Domestic offsets • International offsets	• Not yet applied in the context of adaptation	• Efficient allocation of funds
Related market mechanisms	• Payments for ecosystem services (PES) • Water markets • Habitat banking	PES so far mainly relate to • Forests, • Wetlands, • Biodiversity, • Watershed protection. Water markets have been applied in • Agriculture, • industry (as a user and as an inventor of technological solutions for more efficient water use), • private households, • water-related ecosystems. Habitat banking has not yet been applied	• Fund raising/mobilization & efficient allocation of funds & promotion of adaptation

Following the above, the major objectives of market mechanisms in the context of adaptation can – depending on the design - be:

a) Fund raising/mobilization for adaptation activities
b) Efficient allocation of funds that are available for projects aiming to avoid climate change related damages, and - to a lesser extent:
c) Promotion of adaptation by various stakeholders

It is clear that the specific design of a mechanism will determine focus of its objective. Interestingly, sharing of risks cannot be considered as a major objective of an adaptation market mechanism. In the following, we will therefore not analyse financial instruments with a focus on risk sharing/transfer. Regulatory measures are also not analysed in more detail since the nature of this policy instrument category is too different from the one of market mechanisms.

Challenges and barriers of applied adaptation policy instruments

The instruments mentioned above face several challenges and barriers when applied. In the subsequent paragraphs, we describe major issues and highlight lessons to be learned for the design of market mechanisms for adaptation.

Public-Private-Partnerships (PPPs)

General description

In the past decades, PPPs have been used in numerous occasions for public infrastructure projects, such as building of schools, hospitals, etc., and also for implementing specific capital projects such as the Channel Tunnel Rail Link in the United Kingdom.

By today, PPPs are designed in manifold facets. Their major characteristic is that in PPPs, governments/public institutions and private sector actors conclude a legally-binding contract for the provision of assets and/or the delivery of services. Doing so, there is an allocation of responsibilities and business risks among the various partners. Typically, the government/public actor remains actively involved throughout the project's life cycle. The private sector is responsible for the more commercial functions such as project design, construction, finance and operations. Major types of PPPs are public contract, service concessions and licences. Financial instruments can also be categorised as PPPs if a public entity is involved e.g. as the lender (Butzengeiger-Geyer, Schulze et al. 2011, p. 52ff).

Challenges and barriers

Regarding service concessions it is worthwhile noting that they only reach an intermediary, i.e. the concessionaire, but not the end-consumer. So any incentive that is implemented through a service concession can only have indirect effects to the general public. Hence, it seems questionable whether a "service concession with regulative elements" can bring more value with regards to adaptation than an approach where the service/good is provided directly by a public entity (Butzengeiger-Geyer, Schulze et al. 2011, p. 52ff).

Financial instruments (promotion of adaptation investments)

General description

Financial instruments to promote adaptation can either be realized by loans or by guarantees that trigger or facilitate investments in adaptation by private and public actors.

Loans represent repayable debt where the creditor additionally receives a margin consisting of the interest and administrative costs. Loans can in different fashions be combined with grants, either by charging interest rates below market level or by directly awarding payments for the investment itself or its implementation. More PPP-related are funds where public and private institutions contribute to the overall funding. This enables the bundling of resources as well as the sharing of credit risks.

Guarantees transfer the default risk of a loan from the (private) creditor to the (public) institutions providing the guarantee. This instrument aims at enhancing the financing of projects without directly awarding a grant or some other form of payment. It facilitates credit transactions by lowering the costs due to default-related interest payments. Guarantees can be interpreted as PPP when either the lender or the provider of the guarantee is a public institution and the other part is played by a private institution. Guarantees do not need to focus on one project but could also back a certain amount of money which then finances a larger number of projects.

The instruments mentioned above aim at the provision of the means to (or the enhancement of the) mobilise an investment. Thus a principal link to adaptation exists if these instruments are used in order to finance or to implement private actions which would have otherwise not taken place. In the original context innovative small and medium sized enterprises are addressed as they often face financial limitations, i.e. a lack of venture capital to start a promising business (Butzengeiger-Geyer, Schulze et al. 2011, p.56).

Challenges and barriers

Considering loans and guarantees, it is unlikely that simply raising the amount of available loans/guarantees will raise significant investments in adaptation as in most cases the financial benefit that can be realised is rather low. Combinations with other policy instruments like grants could set adequate incentives but solely applying loans/guarantees will not be sufficient to trigger broad adaptation activities. The only exception may be small companies/entrepreneurs that do not have access to market loans and that plan investments that will create revenues in the future (e.g. agricultural sector) (compare Butzengeiger-Geyer, Schulze et al. 2011, p. 57).

Subsidies

General description

Subsidies can be implemented in form of direct payments (often called “grants”), tax reductions or price supports. The purest form of a subsidy exists if an economic entity receives an amount of money or an expenditure reduction which is supposed to induce the recipient to undertake a specific

action bound to that financial incentive. In absence, the action is presumably not undertaken or not to the desired degree (see also Gupta et al. 2007, p. 750).

Hence, subsidies aim to mobilize investments that are not attractive to the recipient per se. The level of a subsidy should be just sufficient to make the investment economically attractive as otherwise public money is wasted. Therefore, policymakers need to assess the economics of the activities before introducing subsidies and to reassess subsidy levels periodically. In order to make subsidies closer to market-based instruments, two options exist: either a fix subsidy is paid per unit of public good achieved (through which money is wasted if some projects have a lower gap) or a competitive tendering process assures that only projects with the lowest cost per unit of public good are receiving the needed subsidies.

Challenges and barriers

A general reason of the inefficiency of subsidies is that it gives polluters an incentive to pollute more in order to receive more subsidies, or to providers of public goods (e.g. adaptation) an incentive to delay the provision of the public good until the subsidy is secured (see Baumol & Oates 1988). This problem is similar to the question of "additionality" within the CDM.

Furthermore grants and direct payments are usually bound to a pre-defined budget. If the whole amount is consumed, further action is thwarted. This requires constant steering by the budget administrator, both in setting the right level of granting for adequate incentivizing adaptation activities as well as in the overall amount of resources that are spent.

Competitive tendering as a variation of subsidies has further challenges as the UK tendering process for non-fossil electricity has shown: projects other than wind and waste incineration had no chance for receiving funding (Reiche & Bechberger, 2004), many wind projects (winning in the tender) have never been implemented and some stakeholders have missed the capacity for taking part in the tendering process (Markard & Petersen, 2009).

Compared to grants, tax reductions are often easier to administer. However, some major challenges and barriers have been identified by assessing tax reductions: they add to the complexity and opacity of tax systems, their budgetary consequences are sometimes difficult to estimate and they are prone to lobbying before implementation. All these aspects have to be carefully judged before introducing tax reductions (OECD 2010a). Furthermore, expedient tax reductions with adaptation benefits would have to be identified: will e.g. tax reductions for adaptation measures (e.g. building dams) or for persons most vulnerable to climate change lead to more adaptation?

Price supports belong to the group of indirect subsidies although some direct payment is usually associated with them. In its most common form, the government defines a price floor for a good and pays the differential amount to the producers of the good as soon as the market price falls or is below this minimum level. This prevents the price to fall short of the minimum price. Providing price support as a third possibility of subsidies need to be carefully designed and assessed because they distort markets and individual decisions, they redistribute income and resources between economic sectors and between producers and consumers and they demand sufficient financial resources by the government being responsible for delivering the support. Besides, high administrative costs can occur and the instrument is prone to lobbying (compare to Porter 1990).

Taxes and fees

General description

Taxes are monetary payments by economic agents to the state which do not trigger any service in return. First and foremost taxes are needed to generate government revenue. These revenues are necessary to finance public expenditures, these might be adaptation activities. Additionally taxes can be used to influence private behaviour which in some markets does not lead to an optimal outcome. This is normally due to differences between the individual cost of consumption and the social cost. In this case taxes can be used to direct private behaviour towards a socially optimal behaviour. Then taxation has a double dividend: it improves market behaviour and leads to government revenue at the same time.

There is another reason to tax some private goods. If individuals are myopic they might underestimate the true long run costs of the consumption. As an example take areas where forecasts show that they will be vulnerable to flooding in the future. If this is not taken into account adequately be market participants the government could levy a tax on the use of this land area. Therefore the land becomes less attractive and potential users might decide to use other less vulnerable land (see also Kline and Wichelns 1995) .

Fees are similar in nature, but they would by definition require some type of service from the collecting (public) institution in return. For instance, private or public actors have to a pay for the right to use certain land areas or goods owned by the state. By definition of the level of fees the state is able to influence the behaviour.

Challenges and barriers

Taxes as an instrument for adaptation imply that the government has a better knowledge of future costs than the market or the participants behave myopically. This is not at all clear, since one of the features of a functioning market is that all available individual knowledge is gathered and feeds into market results. Furthermore the state is required to assess effects and readjust taxes periodically to achieve the pre-defined objectives of the tax (also compare Baumol 1972).

When applying, the counterpart of the state, the private or public actor, may decide if he is willing to pay. However, comparable to taxes, the state has to assess effects and readjust fees periodically to avoid mal-adaptation or overregulation of land-use or use of goods (Butzengeiger-Geyer, Schulze et al. 2011, p.40).

Quota systems, project offsets and related market mechanisms

General description

Neither *quota systems* nor *project offsets* have yet been applied for adaptation. Since we will describe their functioning at the example of mitigation policies in chapter 3 below, we do not discuss them here. However, there are related market mechanisms that have been applied in contexts

related of adaptation, namely payments for ecosystem services, water markets and habitat banking. It may be noted that, depending on the design of the instruments, they could also be categorised as subsidies or quota systems. In the following, we consider them as independent instrument types.

Payment for ecosystem services (PES) means a voluntary transaction where a well-defined environmental service is being bought by at least one buyer from at least one provider if that provider secures the provision of the service. As long as the benefits from changing the ecosystem are larger than conserving it, a payment is needed in order to avoid e.g. conversion of forests to pasture. The difference of these benefits indicates the minimum payment, while the potential (external) costs to others mark the upper bound of the payment. The payment then has to make the ecosystem manager at least indifferent between his two alternatives. One of the main features of PES is that the polluter-pays-principle is replaced by the beneficiary-pays-principle. Those who are interested in a specific environmental service compensate those actors who would have otherwise degraded the service by alternative usage. Working PES-schemes then need answers to the questions who is the seller, who is the buyer, what is the environmental service, how is the degree of conservation measured, how do the payments work and who initiates and administers the scheme (Engel et al. 2008).

Water markets may generally address the domestic/municipal, the industrial and the agricultural sector. One has to add that these sectors, to a differing degree, consume tap and/or ground water. Around the world, fresh water resources are very unevenly distributed. An intensification of this, paired together with increasing average temperatures, calls for the efficient use of scarce water supplies. Therefore, the efficient (and appropriate) pricing of water is one of the key tasks for climate change adaptation. To date, water markets in many countries are either non-existent or do not price water efficiently, which might cause an overuse of the resource (compare Agrawala & Fankhauser 2008).

Habitat banking aims at conserving the ecosystem services of land, including biodiversity. Credits are given for the creation, restoration and enhancement of habitats, while debits occur when ecosystems are unavoidably degraded or destroyed, for example by development actions. Instead of prescribing on-site offsetting the credits allow to take compensating actions on other venues. This is often referred to as a no-net-loss policy, because the goal is not to fall short of an overall threshold of ecosystem services or biodiversity respectively. The concept adheres to the polluter-pays-principle, because the economic agent reducing ecosystem services on one site has to pay for the damage incurred by financing habitat projects on other sites (see also Wunder 2005; Engel 2008)).

Challenges and barriers

While some PES-schemes have already been implemented around the globe, none of them has the explicit and exclusive goal of adaptation to a changing climate. Adaptation is rather a positive side effect of existing programmes, because their crucial aim is usually to preserve the services of specific ecosystems. One could argue though, that losing the adaptive benefits of certain ecosystems causes (external) costs, which have not yet been considered when setting up PES-schemes. Apart from this, especially state-financed programmes could suffer from (long-term) budgetary restrictions.

Regarding water markets the challenge stems from the fact that ground water is very often treated like a public good or that it at least comes at a very low price. This may lead to opposite developments and conflicts of interest especially in the context of developing countries:

On the one hand, water access has often been appropriated by rich segments of society, while poor segments have to resort to private water markets, which charge prices that are an order of magnitude higher. Charging a uniform and "fair" market price to everyone could lower the expenditures of the poor while raising those of the rich. Thus the problem has more to do with appropriate pricing of water use (or other incentive mechanisms) than with adequate water prices as a market result.

On the other hand privatization of water resources has also led to monopolistic positions of water supply entities with irresponsible price increases for poor population. As a consequence people have not been able to fund their fresh water supply anymore which created social tensions and strong resistance[2]. It is possible that privatization of basic needs like water resources might generate a conflict of interest between social responsibility for the poor, profit maximization of enterprises and ecological or adaptive motivation of governments. Thus when considering substantial price increases for fresh water, access for and social conditions of poor population should be considered.

The link between habitat banking and adaptation is obviously indirect. The instrument would be overburdened by using it explicitly for adaptation and not only for the original purpose, namely the conservation of nature (Butzengeiger-Geyer, Schulze et al. 2011, p.46-51).

Lessons learned when proposing adaptation market mechanisms

The assessment of the various policy instruments targeting adaptation shows that they have certain individual strengths but also face numerous individual challenges, as shown by Table 3. In case of financial instruments, applicability to adaptation is restricted: risk financing only addresses very specific areas or sectors and loans only incentivise special target groups. Comprehensive knowledge ex-ante is needed to avoid uncertainty of either price or adaptation effect. Furthermore restricted budgets might cap adaptation activities to an insufficient level. Equity is an issue in case of all policy instruments, e.g. by creating windfall profits.

[2] As an example, the privatization of the water supply in the Bolivian city of Cochabamba led to significantly increased water prices in the year 2000. The new owner, an international consortium led by US enterprise Bechtel immediately raised tariffs by 35 % to 55 % which was unaffordable for large parts of the population. As a result the price increase created social tensions, protests, general strikes and violence with several deaths and a 90 days "state of emergency" for the whole country (see also Amnesty International 2000, World Bank 2002, p. 3).

Table 3: Challenges of different policy instruments

	Uncertainty of effect	Uncertainty of price	(Sectoral) applicability	Budget constraint	Non-Additionality	Windfall profits	Lobbying distorting prices
Subsidies	↯	✓	✓	↯	↯	↯	↯
Taxes / fees	↯	✓	✓	✓	✓	✓	↯
Public- Private Partnerships	↯	↯	✓	↯	(↯)	↯	(↯)
Financial instruments	↯	↯	↯	↯	(↯)	↯	(↯)
Tradable permits	✓	↯	✓	✓	✓	↯	✓
Project offsets	✓	↯	✓	✓	↯	↯	✓

↯: challenges; (↯): part challenge; ✓: no challenge

3. Lessons learned from mitigation policies

Mitigation of greenhouse gas emissions has seen the application of all types of market mechanisms in the past two decades. This has been a useful laboratory to test the appropriateness of market mechanisms and provides useful lessons for the design of market mechanisms for adaptation. In this chapter, we review three policy instrument types: cap-and-trade (sub-type of tradable quota systems), project offsets and carbon taxes.

Overview of major market based instruments from mitigation policies

Cap and trade mechanisms

Cap and trade mechanisms limit the total amount of greenhouse gas emissions for an entity and allocate it in units, most commonly called allowances. The Kyoto Protocol of 1997 provides an emissions cap for industrialized countries for the period 2008-2012, which can be traded among countries. It took quite some time for governments to engage in transactions and by end of 2010, the trading volume had only reached 244 million t CO_2 (PointCarbon 2011). The main reason for the sluggishness of transactions was the structural surplus in emissions allowances held by countries in transition. Potential government buyers feared that acquisition of such surplus, colloquially called "hot air", would not be supported by the electorate who would see it as cheap "indulgence payment".

The EU has introduced a trading scheme for CO_2 emissions of about 11,000 large industrial emitters from 2005 onwards, the EU Emissions Trading Scheme (EU ETS). This system, which is enforced by high penalties, has generated the highest degree of activity of all carbon market mechanisms to date. Since its introduction, over 16.5 billion allowances have changed hands. However, the system has shown that the setting of the cap needs to be done carefully. Naturally, emitters tried by all means to enhance the allocation of allowances they would get, blowing up the cap. Already after the first year of the first phase it turned out that there was no scarcity of allowances which led to them becoming worthless as they could not be used after the end of 2007. While the EU Commission took this lesson to heart and considerably revised the allocation proposals of member states for the period 2008-2012 downward, the eruption of the financial crisis and the resulting plunge of industrial production again led to the situation that there was a surplus of allowances. However, this time the price did not collapse as the Commission had allowed banking of allowances into the phase 2013-2020, for which a stringent allocation had been published ex ante.

Through persistent lobbying emitters covered by the system had been able to get cost-free allocation of allowances according to historical emission volumes. In markets without international competition such as electricity production, the allowance price was priced in and the companies made substantial "windfall profits" as they did not have any costs for acquisition of allowances. To prevent further windfall profits, in the period starting in 2013, a substantial share of allowances will be auctioned.

An unexpected challenge resulted from fraudsters exploiting security gaps of the trading scheme. Not only did a multi-billion Euro carrousel fraud develop, which defrauded the tax authorities by claiming a refund of (never paid) value added tax for cross-border transactions, but also millions of

allowances were stolen from company accounts through phishing attacks. The trading scheme was disabled for several weeks.

Despite these flaws, the EU emissions trading scheme has shown that a cap and trade mechanism can work in a large scale, provided policymakers are willing to confront power full lobbies head-on to set ambitious caps.

Project offsets

Even in countries where no emissions cap is set, tradable emissions credits can principally be generated by projects. This requires the specification of a baseline emissions level and the check whether the project would not have been implemented in the absence of the incentive provided by the sale of the emissions credits. Furthermore, project offsets need buyers, which can be motivated by either voluntariness or compliance with regulations.

In the context of the Kyoto Protocol, two project-based offset mechanisms were introduced: the Clean Development Mechanism for emission reduction projects in developing countries and Joint Implementation (JI) for projects in industrialized countries. The CDM has been a resounding quantitative success, mobilizing almost 5,000 projects by end of 2010 with an estimated volume of over 2 billion emission credits before the end of 2012. JI was a bit slower but still counted almost 400 projects and 400 million credits.

The key challenge for project-based offsets has been the high complexity of the so-called project cycle that generates substantial transaction costs. An elaborate system of checks and balances was built up to prevent business-as-usual projects and to make sure that emission credit issuance is based on properly verified numbers. A vicious circle developed because the independent auditors of project documentation essentially failed in weeding out black sheep. Thus double and triple checks had to be introduced leading to long delays in project registration and the emergence of a substantial bureaucracy.

Carbon taxes

Carbon taxes were first introduced in the 1990s in Scandinavia. They have not spread substantially since, but there at least some countries in different world regions have introduced some form of carbon taxes – Denmark, Finland, Ireland, Norway, the Netherlands, Sweden, Switzerland and the UK in Europe and some states, counties and cities in North America (e.g. British Columbia, Quebec and Boulder city)

In addition, numerous countries have implemented different variations of energy taxes that apply to various sectors. Some of these taxes cover fossil fuel resources, other target energy output and again others target energy consumption. A major differentiation between taxes and cap and trade systems is that they do not prescribe a pre-defined absolute emission target. In times of strong market demand for a carbon-intensive product, target uncertainty is a disadvantage from the environmental point of view. However, in times where there is a low market demand for the same product, taxes still have a regulating effect, whereas a cap and trade system may have low environmental benefits, as the market price falls.

Subsidies

Subsidies have rarely been applied to buy greenhouse gas mitigation[3] but are widely used to promote renewable energy and energy. The only direct subsidy for greenhouse gas reduction was the so-called "auction" in the context of the UK emission trading scheme in 2003. To entice companies and public institutions to take up an emission target, a subsidy of 215 million £ was offered. 32 companies bid for the subsidy in an "auction", which generated a subsidy level of 17.79 £ per t CO_2. (Smith and Swierzbinski 2007, p. 135).

Renewable energy and energy efficiency subsidies have taken a massive upswing since the late 1990s, when it became apparent that feed in tariff systems mobilized rapid expansion of renewable energy systems. In 2009, renewable energy subsidies totalled 45 billion $ (Morales 2010).

Major challenges and barriers that faced by these instruments

In the following paragraphs, we describe major challenges and barriers that have been encountered by the policy instruments above. In addition, we derive recommendations for market mechanisms in the context of adaptation.

Cap and trade mechanisms

The major challenges that occur when designing and introducing cap- and trade systems are the definition of the cap (or: the environmental target), the definition of participants (i.e. the entities that need to comply with the target) and the allocation of the emissions target to individual participants (Butzengeiger et. al., 2001). It is clear that all these items interrelate with each other and the optimal solution will depend on the specific situation applicable to the new instrument. However, at least one uniform practical challenge also exists: availability of good data. As a general rule, the more sophisticated the allocation method is, the more accurate and detailed data is often required. This needs to be considered seriously from the beginning in order to avoid later backlashes.

Project offsets

Lessons learned from the existing project-based offset mechanisms are manifold with viewpoints being very much politically coloured. The most important ones are:

- Additionality: Given the fact that emission reduction credits can create significant economic value for a project there is the risk of cheating by project developers; i.e. they might claim credits for activities that would have happened anyway or overestimate the emission reduction levels of projects. In order to avoid this, a detailed rules system has been developed. This was particularly important in case of the CDM as here not only monetary damage can arise but also environmental one. In case of adaptation, the anticipated benefits

[3] Subsidies are often used as non-market instruments in case of public funding directed to developing countries (e.g. Global Environment Facility): the funding is not allocated according to efficiency in reducing greenhouse gas emissions but rather for alleviating different mitigation barriers (technology, policy, information) or even for projects with high development benefits.

are of economic, social, health and potentially environmental nature. Hence, a similar control will be equally important as in the case of the CDM: one will carefully need to evaluate the baseline and additionality of adaptation activities.

- Monitoring, reporting and verification (MRV) is an important feature of the CDM in relation with the previous point. One has developed detailed MRV rules per project type because the technical features of projects vary significantly. A key feature was to adapt an ex-post MRV approach to verify the ex-ante emission reduction projections. A similar approach is advisable for the case of adaptation projects.
- Multiple targets: On a political level, the CDM often faced challenges because of its twofold function, i.e. to help industrial countries to meet their emission reduction targets, and at the same time to support developing countries with their sustainable development. The CDM often was accused not to sufficiently support the latter target. For adaptation, it would be helpful to either define only one political target, or to clearly prioritize among targets.
- Institutional capacities: Given the (wanted) variety of different project types eligible under CDM/JI project types, there was a need to evaluate some features on a project type or project level. This includes the additionality criterion and determination of emission baselines. In the case of CDM, a highly complex system has evolved over time that includes several instances of checks and balances. This had not only caused high transaction costs for all actors involved but also led to a delay in project approvals and caused significant capacity needs for national approval authorities and international regulators. In order to avoid discouraging delays for adaptation projects, institutional capacities should be planned in a sensible way.
- Pilot phase: Both JI and CDM benefited from a pilot phase for project offsets, the so-called Activities Implemented Jointly (AIJ) phase. Similarly, the first phase of the EU emission trading from 2005-2007 served for experimentation prior to the start of the Kyoto Protocol commitment period in 2008. In our view, such pilot phases would be very helpful for adaptation market mechanisms as well as they allow to gain valuable experience with both political issues (e.g. rule testing) and practical issues on project level (e.g. availability of data).
- Continuity and adaptation of rules: At the same time, the regulatory framework should be developed in a way that allows for continuous improvement of rules – while acknowledging the need for planning certainty by project developers. A criticised feature of the CDM is that rules changes and changes in approved baseline and monitoring methodologies can (and do) occur on a very ad-hoc basis that affects projects that are in the validation pipeline. An easy solution would be to agree that no rule changes shall apply to projects once they have reached a certain status.
- Capacity building: There was a huge need for capacity building and know-how transfer on all levels: project developers in host- and investor countries, approval authorities in host countries, investors, financial markets, supervisory bodies etc. It is likely that similar need will occur with regards to adaptation market mechanisms.

A more detailed discussion and evaluation of project based offsets can be found e.g. in Michaelowa and Müller (2009).

Carbon taxes

It goes beyond the scope of this paper to look at all types and variants of carbon taxes, but on a general level there are still interesting lessons to be learned. While a carbon tax levied evenly across major sectors can be an efficient instrument, no carbon tax has been designed in such a manner. A major lesson is that exception clauses – which typically occur due to intensive lobbying of interest groups - need to be considered very carefully in order to avoid perverse incentives and biased structuring of the system. For example, Bruvoll and Larsen (2004) show that such exemptions considerably weakened the effect of the Norwegian carbon tax. Often, strong political interest emerges to remove or lower taxes for certain sectors, or to define other exceptions. Overall, one needs to be aware that taxes are very exposed to severe political lobbying (Blanke 2002).

Subsidies

Subsidies generally exhibit features that promote inefficiency. In the UK CO_2 subsidy case, price levels in the emissions trading system were much lower than the initial subsidy. This could be due to the fact that companies did not know their real marginal abatement cost curves or were risk averse (Smith and Swierzbinski 2007, p. 144f) or just that they knew the government was desperate to get the system going and thus willing to pay a high price.

Renewable energy subsidies have contributed to keeping unit costs of renewable energy high as technology producers concentrated on maximizing production instead of reducing costs. This is due to capture by increasingly powerful interest groups (for an analysis of the German wind energy lobby see Michaelowa 2005). For example, wind turbine and solar PV unit costs increased since the late 1990s when subsidy systems multiplied (for wind see EWEA 2009, p. 203). Only the financial crisis from 2008 onwards and the ensuing reduction of unit subsidy levels due to budget constraints broke this upward trend (see Deutsche Bank 2009, p. 48). How subsidy reductions mobilize cost reductions can nicely be seen in Deutsche Bank (2011, p. 12).

4. The way ahead for adaptation market mechanisms

As pointed out above, market mechanisms for adaptation may have different designs and will face different challenges. In the following, we will line out the different design options and assess if the preconditions for their establishment are already met. Finally, a pathway for setting-up market mechanisms will be described.

Design options

When thinking about design options for international adaptation market mechanisms, we will focus on instruments with positive incentives ("carrots") to provide the public good of adaptation (i.e. "promotion of adaptation", see chapter 2). Options including negative incentives ("sticks") such as taxation of risky activities will face higher political opposition. Tax reductions are also not assessed, as they can only be applied on the national but not on the international level. We thus assess:

- fixed subsidies per unit of adaptation,
- competitive tendering for a pre-defined subsidy volume, and
- adaptation quotas denominated in tradable certificates.

The first option is *fix subsidies per unit of adaptation.* In one variant of this option, fixed payments are made ex-ante to make sure that investment funding is available, given that most adaptation projects require high up-front investments and do not generate revenues over time. A challenge in this variant is the incentive for project proponents to distort the baseline (e.g. by asking for funding for autonomous adaptation measures) or only to announce but not to implement adaptation measures, given that the funding was received ex-ante. Thus, in-depth review of forecasts and a close monitoring process has to be included in such a scheme, as well as a pay-back clause in case of fraud. In the end, payments per real achievements can only be guaranteed in case of the second variant, fix payments ex-post. However, in this case the risk for investors is high. Therefore, high knowledge about climate change and adaptation measures is needed. Therefore, these ex-post payments may only contribute a small part of total funding, as long as risks are still high.

The second option is *competitive tendering*. In this case, a certain amount of funding will be tendered, and project proponents would have to show how many adaptation units they can achieve per $ of funding. In a variant, bidders will have to show how much funding they need to achieve a certain amount of adaptation units. Only the projects with the best cost-to-adaptation-benefit ratio will be selected for funding. The challenge of this option is to accurately verify the predicted adaptation achievements, similar to the fix payments ex-ante option. To circumvent this problem, the payments may only be made in case of successful achievements. This would, however, deter proponents from bidding.

The third option, *tradable certificates to achieve adaptation quotas* is the most challenging but may also become the most effective and efficient solution in the long run. Certain nations (or even companies) will have to be obliged to generate or procure a certain amount of adaptation certificates in a given time period. Then, adaptation projects will receive adaptation certificates depending on the achieved adaptation units. Issued certificates will be traded at a fluctuating market price between owners and users of such certificates. Challenges for this option – besides the political one

to agree on “adaptation quotas” - are again baseline and ex-post verification, as well as the governance of registries and trading platforms.

Political requirements for adaptation market mechanisms

A series of requirements will have to be met in order to allow adaptation market mechanisms to function. These preconditions can be differentiated between political and technical ones.

Political decisions are required before any market mechanism can be technically implemented. The four principal political requirements are: adaptation unit definition, target definition, political acceptability and availability of funding.

The initial political precondition is to define the adaptation unit. The literature on the evaluation of adaptation projects such as Eriksen and Kelly (2007) and Hallegatte (2009) stresses the difficulty of defining impact indicators for projects, while Persson (2011) even states that the lack of adaptation metrics is one reason why markets focusing on adaptation benefits are not feasible[4]. On the global political scale, no harmonized indicator for the adaptation unit can be found apart from “economic value”, the measure used by most adaptation economics studies (Economics of climate adaptation, 2009; Moench et al., 2009), and “reducing vulnerability/increasing resilience”, the unspecific goal mentioned in most governance documents (GEF, 2009; AFB, 2010: 6). In a separate paper we have proposed to use economic and health benefits as two general indicators for defining the adaptation unit, while establishing no-harm standards for environmental and cultural aspects. By this, both “reducing vulnerability” and “economic values” can be captured.

For a trading scheme, an adaptation target needs to be defined for each type of adaptation unit politically agreed (e.g. 1 million lives and 10 billion USD to be saved per year by companies of country x in region y). Such targets require decisions about the degree of adaptation seen as necessary. The establishment of quantitative adaptation targets has not even been discussed on the political level at all and therefore requires a strong push by researchers and analysts alike.

The acceptability of market mechanisms cannot be taken for granted. Discussion of adaptation funding is heavily interrelated with equity issues. International adaptation funding is meant to support the most vulnerable according to all recent climate agreements (UNFCCC, 2008, 2009, 2010). However, market mechanisms are not expected to necessarily reach the most vulnerable. Indeed, market mechanisms may even intensify inequality as poorer (and, therefore, often more vulnerable) citizens may be less capable of converting income (e.g. adaptation funds) into opportunities (Sen, 1993). Related to this argumentation, the hot spot problem (Stavins, 2003)[5] may arise: some places heavily affected by climate change may receive no funding just because other places, with higher adaptive capacity and good institutions provide lower-cost adaptation options. Ways to reach political acceptability of market mechanisms would be to either define the adaptation unit in a way

[4] Persson (2011) sees an alternative adaptation market, based on *credits for spending adaptation funds*, as more realistic and finds patterns of early demand and supply but no true adaptation market place. While this “adaptation funding market” may indeed be more realistic compared to the “adaptation benefit market” we describe here, one may question the use of a credit that merely shows that adaptation funding has been spent.

[5] Stavins actually refers to environmental pollution when explaining the hot spot problem: In this case, market-based mechanisms may lead to very high pollution at specific places just because its abatement is expensive.

that it mainly benefits the most vulnerable or to earmark a certain share of adaptation funding for the most vulnerable, while the rest is allocated through market mechanisms.

The fourth political precondition, required in case of tendering or fix payments, is the availability of adaptation funding. With the Adaptation Fund and other bilateral / multilateral initiatives, at least a sizeable level of funding is already available, so the question is rather whether political acceptability of its use for market-based instruments is given.

Technical requirements for adaptation market mechanisms

Apart from those political requirements, there are three primary technical preconditions for establishing adaptation market mechanisms: predictability, ex-post measurability of adaptation achievements and difference in unit costs.

First, predictability of adaptation achievement is important in all options: it has to be possible to evaluate ex-ante how many adaptation units can be achieved with a specific project. If predictability is not given, either the policy makers do not know how to allocate funding and/or the investor lacks the needed information on expected later payments. Predictability is a really difficult criterion in the climate change adaptation context, as one needs detailed information on (local and regional) climate change, autonomous adaptation, change in socio-economic conditions and effectiveness of measures. All of this information is nowadays either not given or highly uncertain (see Adger et al., 2007).

Second, measurability of adaptation achievements has to be given in case of ex-post payments or issuance of certificates. Measurability/verifiability means that the level of adaptation units (e.g. lives or USD) would need to be monitored and compared with a hypothetical baseline. Again, as in case of predictability, detailed information on local and regional climate change, socio-economic development and baseline/autonomous adaptation has to be known. While information availability is far from optimal, the quality of data will be better than in case of predictability: ex-post adjustments can be made and climate as well as economic models will improve over time.

The issues of predictability and measurability are not trivial for adaptation policies. Measuring and verifying may include high transaction costs, which can be a major hurdle for market-based instruments (Stavins, 2003). If not enough information is available, and uncertainty will be reduced in the future (as is probably the case for adaptation), decisions may have to be postponed[6]. Given the uncertainty but also the high risk of climate change, it may be recommendable to focus adaptation not mainly on fixed investments (for which market mechanisms are best adapted) but also to flexibilize the capital stock, invest in research, strengthen knowledge-exchange institutions and establish risk-sharing instruments (Fankhauser et al., 1999). Therefore, market-based mechanisms with their need for certainty in predicting and measuring adaptation achievements may only be suited for specific adaptation measures, such as investments where certainty of returns are high (e.g. dams). Soft measures such as capacity building or research are better funded through a separate funding channel.

[6] Hanemann (1989) speaks about the option value in such cases.

A third technical precondition is the availability of different unit costs (Stavins, 2003). Market mechanisms are only expedient if costs to achieve adaptation units differ. This precondition is easily met: Economics of Climate Adaptation (2009) show that cost-benefit ratio differ considerably among projects.

Once these main technical preconditions are met, the following governing functions have to be assigned to existing or newly established institutions: allocation of funding, verification, issuance of certificates, disbursement of funds, appeal procedures, enforcement of rules, establishment of trading platforms and anti-fraud mechanisms[7].

Table 4 shows the requirements to be met for each market based-instruments (marked with a plus) and non-met conditions (marked with a flash). For all options, some preconditions are not met, such as definition of indicators and political acceptability. The option where most preconditions are met is fix payments (subsidies) *ex-post*: assuming minimal measurability is given, the only further precondition is political acceptability. Other options require further preconditions to be met: Fix payments (subsidies) *ex-ante* need minimal predictability of adaptation units, while competitive tendering even requires strong predictability. Finally, tradable units require the definition of adaptation targets and thus a strong increase in political salience of adaptation.

Table 4: Requirements for market-based instruments in adaptation policy

	Political requirements				Technical requirements		
	Metric for adaptation unit	Political acceptability	Adaptation target	Funding availability	Predictability	Measurability	Different unit costs
	Not given	*Not given*	*Not given*	*Given*	*Not given*	*Partly given*	*Given*
Fixed subsidy (ex-post)	+↯	+↯	0	+✓	0	+(↯)	+✓
Fixed subsidy (ex-ante)	+↯	+↯	0	+✓	+↯	(+)(↯)	+✓
Competitive tendering	+↯	+↯	(+)(↯)	+✓	+↯	(+)(↯)	+✓
Quota & tradable units	+↯	+↯	+↯	0	(+)↯	+(↯)	+✓

+ : required, (+) : partly required, 0: not required; ↯: requirement not given, ✓ requirement given

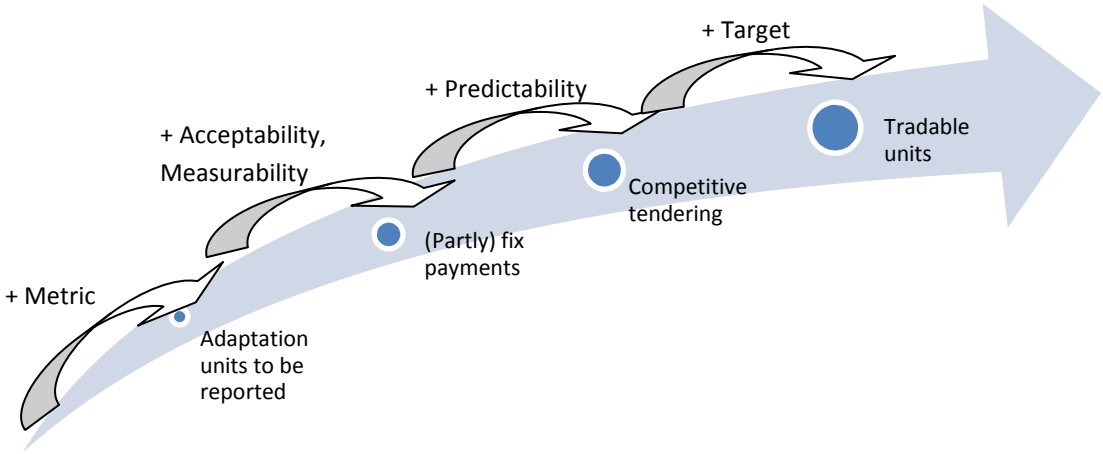
Steps towards market mechanisms

Figure 2 shows possible steps on the way to establishing market-based instruments. The steps, shown by bullet points, can only be undertaken if certain preconditions (marked with arrows) are met. The process starts by defining indicators (e.g. saved wealth and health) and the metric (e.g. lives

[7] Such governing functions are non-specific to adaptation and far from trivial: e.g. many institutions are not perfectly monitoring and enforcing environmental policies (Helfand et al., 2003).

saved, $ saved) for the adaptation unit, which almost happened in the March meeting of the Adaptation Fund in 2011. Given the metrics, projects would be required to report on predicted and achieved adaptation units. This process will help to increase knowledge and certainty on predictions and achievements, as well as to test the feasibility of the given adaptation indicators[8]. Once minimal measurability as well as political acceptability is given, the adaptation institutions could start with fix payments for adaptation achievements ex-post. As most adaptation projects need funding at the beginning, payments may be shifted (eventually under preconditions) to ex-ante, if minimal predictability is given. Predictability would need to be close to perfectness in order to move to the next step, competitive tendering (see also Baca 2010, p.14f). Finally, the establishment of tradable units can only be started, once adaptation targets are set[9]. All steps will first need a pilot phase, either for a limited set of projects or in a selected number of countries (see also Schultz 2011, p.5).

Figure 2: Steps towards market mechanisms for adaptation



5. Conclusions

15 years ago analysts and policymakers frowned at the idea to use market mechanisms for mitigation of greenhouse gases. Currently, the same reaction happens if one suggests market mechanisms for adaptation. However, the success story of mitigation market mechanisms shows that obstacles of political and technical nature can be overcome. While in the case of the CDM, it took five years to overcome the political misgivings and another five years to set up the technical rules, eventually the mechanism has been able to harness entrepreneurship and mobilize thousands of projects. A key requirement for this was the learning through a pilot phase for projects in the second half of the 1990s. In the case of the EU emissions trading system the political learning process was even faster, triggered by the failure to establish an EU-wide carbon tax. A weak spot of the market mechanisms is the gaming by companies, which has occurred in both the CDM and the EU trading scheme. Apparently, it is inevitable that lobbies influence the design of a mechanism in a way that they can reap rents and windfall profits. The only countervailing force is a strong, independent regulator like

[8] This process may be similar as the establishment and review of baseline and monitoring methodologies in case of the CDM.

[9] The tradable units option may be started even before competitive bidding, if adaptation targets can be established early, and perfect predictability is not yet given.

the CDM Executive Board. Monitoring, reporting and verification are key to a good functioning of mitigation markets; it has developed without major hiccups.

If these lessons are translated to adaptation market mechanisms (see also Schultz 2011, p.5), it will require a change of the fundamental principles in spending adaptation funding. Probably only after several years the first scandals will erupt and angry electorates will call for efficient spending of adaptation funding. Then, the political willingness to decide on an adaptation unit and to agree on an adaptation target could develop quickly. Nevertheless, the uncertainty regarding climate impacts, the development of economic activity in areas threatened by climate change and the long-term nature of adaptation projects, as well as the difficulty to evaluate "soft" adaptation activities will be obstacles that mitigation market mechanisms did not encounter. As a starting point, tendering of adaptation subsidies and fixed adaptation subsidies could be tested in pilot phases. Subsequently, trading of "hard" adaptation options could be embarked upon.

In the short term, further research is needed with regards to the definition of adaptation metrics and the specification of baselines for adaptation projects. Here, the evaluation of adaptation projects implemented in the past would be a useful testing ground.

If the political salience of adaptation increases, in 2025 people might wonder why adaptation market mechanisms were seen as a strange idea in 2011. They can clearly make a difference and thus could help in reducing the impacts of climate change that is becoming inevitable due to the slow progress in mitigation.

Acknowledgements

We would like to thank the Swiss Agency for Development and Cooperation (SDC) for funding. This paper has benefitted from the input of various persons, including participants of the "Colorado Conference on Earth System Governance: Crossing Boundaries and Building Bridges."

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